RESEARCH PLAN FOR WEST COAST GROUNDFISH

NATIONAL MARINE FISHERIES SERVICE

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INTRODUCTION

The West Coast groundfish fishery contributes significantly to the economy of fishing communities, to valuable recreational fisheries all along the coast, and to a tribal fishery off Washington. Today**,** West Coast groundfish stocks and fisheries are in crisis and its commercial ex-vessel value has declined from its peak near $100M annually. The fishery is overcapitalized, and several groundfish stocks have been depleted by a combination of fishing and natural factors. Allowable catches must be reduced to levels that cannot economically sustain present participation. Fishing communities are challenged to share this limited resource among all participants. Further, concerns mount that fisheries and other human activities are exerting unknown and possibly significant risks on the marine ecosystem. Finally, the habitat, which supports fish productivity, undergoes natural climate cycles that can both increase and mask the human impacts.

These problems are interconnected, and a holistic solution is needed. Problems in West Coast groundfish fisheries will take years to resolve and will require a long-term commitment of agency resources. Management options are being explored today through the PFMC's Strategic Planning Committee. Implementation of any management options under consideration will require improved information on the fishery. The research program described here is designed to provide needed scientific information and advice for fishery management decisions.

Over the past 20 years, a major component of the groundfish management program has been annual catch quotas for near 20 of the 82 species. For these commercially and recreationally important species, which accounted for most of the historical catch, the quotas are based on scientific stock assessments. For broad groups of the other species, crude limits were set based upon historical catch levels. The quotas are adjusted periodically to levels that are expected to obtain optimum yield while allowing each stock's abundance to be safely fished down to near one-third of its unfished level. Over the past few years, several of the assessed stocks have declined to dangerously low levels near 10 percent of unfished levels. The reasons are threefold:

First, the target harvest rate was an approximation of the unknown optimum rate. This harvest rate was reasonable from worldwide knowledge of other species' productivity, but there was little specific knowledge of the productivity of each West Coast groundfish species. Nor was there knowledge of how this productivity is linked to the California Current ecosystem. We now believe the exploitation rate was too high for many groundfishes, which collectively seem to be relatively unproductive.

Second, there was insufficient resource survey information to estimate stock abundance with adequate precision, insufficient research to forecast the impact of declining recruitment, and no observer program to verify that the actual catch is at the intended level. This uncertainty could have inadvertently led to overfishing because target harvest rates were not set safely below "best estimate" levels.

Third, nearly coincident with the increase in groundfish harvest in the late 1970s was a long-term decline in the basic productivity of the California Current. It is likely that this decline contributed to the decline in recruitment of young groundfish for several species. However, the long lifespan (50-100 years) of many groundfish and the imprecise and infrequent stock assessments delayed detection of the persistent change in recruitment until several years later.

The West Coast groundfish fishery is in the midst of a major transition that will require a fundamental shift in our perception of resource productivity. In the past, annual harvests could be larger because they had a component from population surplus production plus an added component due to reduction in stock size, i.e., the fishery was living on the "interest" and some of the "principal." Due to the expected reduction in groundfish populations during the development of the fishery, a very limited number of stocks are still above their optimum levels. With the implementation of the Sustainable Fisheries Act of 1997 (SFA), however, there is a clear legal requirement that groundfish fisheries be managed to achieve optimum sustainable harvests. For stocks that are at their optimum abundance level, harvests must now be based only on the surplus production of a stock. The "fishing up" bonus is no longer available, and catches must be reduced accordingly to make them sustainable. In some cases, even more severe reductions are required to meet rebuilding requirements.

The challenge today is to provide more accurate information on abundance and potential yield so that we can attain sustainable, valuable fisheries with little negative impact on the marine ecosystem. It is impossible to maximize fishing opportunities while minimizing biological risk without having a high level of knowledge about the fish and their environment. Sustainable fisheries require good resource monitoring, including climate, ecosystem and socioeconomic effects, to track and predict changes in the resource. In addition, scientific advice must more clearly describe the uncertainties associated with the scientific information and the benefits and risks for future management options.

The westcoast groundfish fishery will continue to suffer if we are not able to increase the investment in research. Without conducting baseline assessments on all species, the entire community will continue to be shocked as first-time assessments are occasionally conducted for the long list of unassessed species. Without an improved level of resource assessment surveys we will not be able to timely track the rebuilding of overfished species, thus risking delays in a return to a sustainable fishery. Without a strong, well-accepted research plan we will not be able to efficiently allocate our limited research effort among competing needs such as: rebuilding of overfished stocks; close tracking of optimum yield for healthy fisheries such as sablefish and whiting; and evaluation of ecosystem, climate, and socioeconomic factors.

The overall goal of this draft research plan is to serve as a framework for the entire suite of research needed for westcoast groundfish, to indicate the immediate high priority needs, and to stimulate discussion among agencies and constituents on how we can collectively achieve these goals.

BACKGROUND

The 82 groundfish species can be roughly broken into six assemblages (*Table 1*) based upon their adult habitat and co-occurrence in the fishery. This breakout will facilitate discussion of fishery monitoring and resource survey programs:

a. Midwater- These semipelagic schooling species include Pacific whiting and shortbelly rockfish. These species can be surveyed with acoustic methods, and whiting is surveyed triennially. Whiting supports a midwater trawl fishery with annual catch near 300,000 mt.

b. Deep slope includes primarily sablefish, dover sole, shortspine thornyhead, longspine thornyhead, and Pacific grenadier. They are found mostly on trawlable habitat on the shelf break and continental slope extending out to about 1500m bottom depth. Most of these species recruit on the shelf and gradually move into deeper water as they age. This valuable assemblage supports a multispecies trawl fishery, and sablefish is a target of pot and hook and line fishermen. The slope trawl survey is their primary source of abundance data.

c. Shelf includes 30 rockfish species, lingcod, and Pacific cod. These species occur on the continental shelf. Many species are found over rocky habitat, and some species have significant off-bottom tendencies. The fishery is primarily trawl and hook and line, and the triennial bottom trawl survey is the major source of abundance information for these species.

d. Slope rockfish includes nine rockfish species found on the upper continental slope. The fishery is primarily trawl, and the triennial bottom trawl survey is the major source of abundance information for these species.

e. Nearshore rockfish includes 13 rockfish species and a few other species. They are found mostly in high relief habitat and are caught primarily by commercial and recreational hook and line gear. There are very little assessment data for these species, except for black rockfish off Oregon and Washington.

f. Nearshore flatfish includes 11 flatfish species that are found on trawlable, sand-mud habitat on the continental shelf. The triennial trawl survey provides limited abundance data for these species.

Only 16 of the 82 groundfish species (*Table 1*) have had enough data to determine the status of the species. Most of these 16 assessed species have historically accounted for much of the catch volume. They also have been the targets of fishery monitoring and resource survey programs that provide the basic information for quantitative stock assessments, although not all these assessments have the same level of information and precision. Of the 16 species: 10 have abundances that are near or above the target level (35-40% of unfished level). One species is approaching the overfished level of 25% of unfished abundance. Five species are at depressed levels (abundance near 10% of unfished levels) and have already been declared overfished. Assessments for 10 additional species are listed as "partial" in *Table 1* because they did not have enough data to determine the status of the species abundance. However these assessments did determine that the level of catch for several of these species exceeds biologically acceptable levels. Hence, overfishing has been occurring.

For other species, there is generally insufficient information to determine whether or not the stocks are depleted and whether or not the current level of exploitation is overfishing. Some of these species are small-bodied and are not targeted by current fisheries, but other species are increasingly the target of developing fisheries, such as for live rockfish. Catch limits on some groups of these "unknown status" species have been set somewhat below historical harvest levels, but there is no assurance that even these levels are sustainable. As assessments are conducted for more of the many rockfish species, there are preliminary findings of more species in the low to

depressed state. Further, the Puget Sound populations of some groundfish species have experienced severe declines and currently are under review for listing under the Endangered Species Act (ESA). There is great concern that some of the currently unassessed species have been overfished, and a priority of this research plan will be these first-time assessments.

Reduced abundance and quotas are not the only issue facing the groundfish fishery. Although a limited entry system was established in 1994 for the major segments of the fishery, these segments were already overcapitalized, and new fishery sectors, such as the nearshore live rockfish fishery, continue to grow. The limited entry program initiated in 1994 also provided for the continued existence of an open-access fishery for many species, where the number of participating vessels remains uncontrolled. Although this fleet harvests a small percentage of all groundfish, it has been allocated more than a third of the commercial rockfish catch in California, based on historical landings. Other features of West Coast groundfish create additional assessment and management complexities. For example, the recreational harvest is a major component of the total catch for lingcod and several rockfishes; coastal tribes off Washington harvest sablefish, whiting, and some rockfish; and the distributions of several species span the borders with Canada and Mexico. Nearly all healthy stocks are fully utilized today, and increased domestic production can only come by rebuilding depleted stocks, increasing yield efficiency (full utilization) of capture fisheries, or by developing aquaculture.

Year-round fishing and marketing opportunities are a goal of the groundfish fishery management plan. However, because the fishery is overcapitalized, vessel catch limits on each of several species have been imposed to slow the rate of catch and delay annual quota attainment until late in the year. These vessel limits cause economic inefficiency and indirect allocation among user groups. Further, they cause discard because a fisherman cannot precisely control the rate of catch of each species in this multi-species fishery. Historical estimates of this trip-limit-induced discard were estimated to be near 16-20% of total catch for several species. Yet, without an ongoing, comprehensive observer program these dated estimates are still used for management purposes. Further, retention of Pacific halibut and salmon by groundfish fishermen is prohibited, so all of their bycatch is discarded.

In the short-term, the socioeconomic impacts of harvest reductions needed to rebuild overfished stocks will be severe. A focus of this research plan will be improving understanding of these impacts so that they can be distributed more equitably, and to lead the groundfish fishery towards an economically viable future.

GOALS

This research plan is designed to identify the scientific information and approach needed to achieve NMFS stewardship objectives for West Coast groundfish. These national objectives include:

1. Maintain healthy stocks important to commercial, recreational, and subsistence fisheries
2. Eliminate overfishing and rebuild overfished stocks important to fisheries
3. Increase long-term economic and social benefits to the nation from living marine resources
4. Promote the development of robust and environmentally sound aquaculture
5. Recover and maintain protected species populations
6. Reduce conflicts that involve protected species
7. Protect, conserve, and restore living marine resource habitat and biodiversity

In addition, NMFS recognizes important foundations for a successful research plan including:

1. Development of high quality science that provides basis for management decisions
2. Communication and collaboration with constituents
3. Strong and productive partnerships
4. Effectively conveying results to fishery management organizations.

This research plan is structured by research topic area, rather than the above management goals, because many of our research activities produce results that contribute to more than one of the agency goals. Successful achievement of these management goals is, however, the ultimate motivation for developing this plan. Simply stated, our goal is to provide the scientific basis for stewardship of living marine resources. Scientific knowledge is the key to balancing the attainment of optimum yield with the long-term protection of the resources.

The National Marine Fisheries Service currently works in close collaboration with the state agencies, the Pacific States Marine Fisheries Commission (PSMFC), the Pacific Fishery Management Council (PFMC), and other entities on groundfish. The state-federal partnership has a long and successful history on the West Coast. The PacFIN Data Committee, the US-Canada Groundfish Technical Subcommittee, the PFMC's stock assessment review process, and other forums all provide opportunities for the several agencies to coordinate their research and monitoring programs. The PacFIN program that provides the coastwide comprehensive database of fishery statistics exemplifies the success of this partnership. However, even PacFIN cannot meet all of today's information demands. We must constantly seek ways to more efficiently accomplish today's demands so that we can accomplish ever increasing demands in the future. We must work together to make hard choices about priorities for future research and monitoring efforts.

The biennial report on Research and Data Needs prepared by the PFMC highlights the need for a comprehensive statement of what we are doing, and what are priority areas for further work. The "Working Together for West Coast Groundfish" forum in July 1998 and the "Rockfish Forum" in April 1999 add momentum and constituent support for such a planning effort. Each of these forums generated good new ideas and added support to some commonly identified ideas. The research plan described below benefits from all these past efforts.

PRIORITIZATION

A fundamental issue is determining how to prioritize our research and monitoring efforts among the many short-term and long-term research and monitoring needs. When prioritizing research plans, it is instructive to consider the linkage between information, certainty, and safe management. This is most clearly done in the context of management of fishery harvest levels, but the general precautionary approach has broader application. Simultaneous achievement of a high optimum yield and a low risk of overfishing is impossible without a high level of knowledge. As information improves, the level of certainty in assessment results will also improve (*Figure 1*). Scientific assessments for west coast groundfish has sought to deliver the best possible advice on fishery potential yield, even though all of these assessments have varying degrees of uncertainty. Unfortunately, whenever we make a "best estimate" of acceptable biological yield from a weak knowledge base, there is a high chance that we could accidently miss the true value by a wide margin, high or low.

The Sustainable Fisheries Act compels us to err on the side of safeguarding the resource. A precautionary approach (*Figure 2*) is to scale back the recommended harvest rate in relation to the level of uncertainty in the knowledge of potential yield. Then as the level of knowledge increases, an equal level of safety can be achieved without as large a precautionary adjustment. In order to implement such a precautionary approach, fishery scientists must deliver to fishery managers a description of this uncertainty and an assessment of the risks created by overfishing and other impacts on the stock. Some kinds of information will provide greater improvement than others. For example, developing a time series of fishery catch per effort or developing a rough estimate of fish abundance will let us determine if the current level of catch is in the right ballpark. An annual fishery-independent survey is expected to make a substantial improvement in the accuracy of that determination. Then adding a recruitment survey will add improved forecasting to that accurate assessment. Finally, adding the ecosystem considerations will allow us to adjust management strategies to incorporate knowledge of species interactions.

Process for Prioritization

We use a series of questions to guide decisions about which research has highest priority for funding and staffing in the West Coast groundfish research program. Although this has not been a formal process, we intend to implement a more rigorous process to prioritize research efforts. The questions below, which are not all of equal importance, outline this general approach to prioritization:

1. STATUS OF THE SPECIES/POPULATION (STOCK)
    a. Has the status of the stock ever been assessed?
    b. Is the stock listed as overfished, threatened, or endangered?
    c. Is the abundance level declining?
    d. Is there evidence that the status has changed since the most recent assessment?

2. MANAGEMENT NEED
    a. Does the information resulting from this project have direct applicability and significance to a priority management issue?
    b. Is there a critical management decision that requires this information?
    c. What is the magnitude of the need for this project to achieve overall management goals?

3. BENEFIT TO THE STOCK
   a. Will the research reduce risk to the stock?
   b. Will the research promote rebuilding?
   c. Will the research help maintain healthy status of the stock?
   d. Will the research make a real and significant contribution to the stewardship of living marine resources?

4. SCIENCE NEEDS
   a. Is there a critical science need that this project addresses?
   b. How much does the project reduce uncertainty in the information provided to management?
   c. What is the magnitude of the need for this project to achieve overall goal for species?
   d. Is there an emerging issue or science area that the project addresses?

5. SCIENTIFIC QUALITY
   a. Is the project feasible?
   b. Is the expertise to do the project available in the required time frame?
   c. Is the project well designed?
   d. Is the funding sufficient to achieve statistically valid results?
   e. Is the project state of the art science?
   f. Will the research result in high quality science?

6. FUNDING OPPORTUNITY
   a. Does the project increase our opportunity for new funding?
   b. Does the project increase our opportunity for leveraging or matching funding?

7. BROADENS EXPERTISE
   a. Does the project develop expertise that will have other uses?

As we present the elements of a comprehensive research plan below, we will also identify two tiers of research and monitoring priorities. Selection of these broad priority areas is based upon considering the above questions. While we need to strive to achieve the first tier as soon as possible, we do not expect our work to be entirely sequential and linear among these tiers of information or other research areas. Other considerations include:

a. Species that are listed under the ESA will have more importance for research effort than a healthy species that has been fully assessed over a series of years;
b. If management identifies a particular area where information is urgently needed, that will be given high priority for research effort, if possible;
c. We are not at the same level of knowledge for all stocks of groundfish at this time. Some species need a recruitment survey in order to improve forecasts, whereas other species are in need of a first time assessment;
d. Some time series need to be initiated soon and linked to historical data in order to pay off in the future;
e. Some high priority work (like direct measurement of natural mortality) may not be feasible because of prohibitive expense, or lack of appropriate technology.

f. If the funding is inadequate to do a particular high priority project, then we may consider whether a lower level of funding will provide scientifically valid results or whether a lower priority project would be more cost effective and still provide important information for management decisions.
g. Stakeholders may be interested in investing in particular information, even though this information may not be the highest overall priority;
h. Alternative sources of funding may be interested in research topics that are not highest priority for groundfish.

RESEARCH PLAN

OVERVIEW

This research plan for West Coast groundfish is designed to provide scientific knowledge needed to achieve NMFS strategic objectives with respect to the West Coast groundfish fishery. We identify six areas of research: status of stocks, socioeconomics, manmade stress, ecosystem and climate, technological innovation, and management support (*Figure 3*). Appendix A lays out this long-term research plan in more detail, including information on the current programs and research areas where improvements are feasible.

Within each research area we identify topics that are of primary importance in dealing with the immediate problems of the groundfish fishery. These topics are classified into a top (first) or second tier priority level. In identifying these priority topics, we have focused on the immediate research needs to support a sustainable fishery, and we have estimated the approximate additional annual cost for conducting this work. If we are able to accomplish a significant fraction of this work in collaboration with other agencies and groups, everyone will have greater trust that west coast groundfish are being managed on the basis of good scientific information.

Even achieving these two tiers of priority work will leave unanswered questions. The detailed information in Appendix A is an attempt to lay out the fuller scope of work that could be done to more fully assure a sustainable valuable fishery with acceptable impact on the marine system.

In brief, the six areas of research are:

I. Status of stocks provides the basis for identifying overfished and threatened stocks, guiding and monitoring rebuilding of these stocks, and forecasting biologically sustainable harvest levels for healthy stocks. Stock assessments are conducted periodically to track changes in abundance and are supported by long-term fishery-dependent and fishery-independent monitoring, and life history studies.

1st Tier Priority - Conduct baseline assessments for all managed species, even those with weak databases, to determine which species are probably healthy, and which are at risk of being overfished or threatened.

1st Tier Priority - Improve certainty in assessments for priority species by improving frequency and extent of resource surveys, expanded biological investigations (stock structure, growth, natural mortality, etc.), and better knowledge of total fishing mortality.

II. Socioeconomic investigations determine the social and economic impacts of fishery management actions and harvest policy.

1st Tier Priority - Develop better understanding of socioeconomic issues for West Coast groundfish in order to guide development of an economically viable fishery.

III. Manmade stress includes gear impacts, bycatch, contaminants, habitat alteration, disease, and exotic species. These studies will identify potential risks to fish stocks, their habitat, or other components of the ecosystem. In addition to identifying risks, these studies also seek to develop tools to reduce adverse impacts.

2nd Tier Priority - Determine ecological effects of fishing, including bycatch, and impacts on essential fish habitat.

IV. Ecosystem and climate studies seek to understand the physical and biological nature of the system in which the fishery occurs. Important goals include: (a) determining how natural fluctuations in this ecosystem affect fishery productivity; and (b) how the fishery affects ecosystem function through bycatch, changes in target species abundance, and impact on essential fish habitat. Studies may include identifying essential fish habitat, investigating the potential value of marine protected areas, monitoring ocean climate, and predator-prey studies of important interacting species.

2nd Tier Priority - Improve understanding of decadal-scale ocean climate fluctuations on fish productivity. This will improve forecasts of available yield and forecasts of the time to rebuild overfished stocks.

V. Technological innovations such as electronic logbooks and underwater imaging systems offer potential for more cost-effective and accurate methods to accomplish research and monitoring objectives, but require extensive testing and practical evaluation. Other technology, such as artificial propagation, has the potential to broaden the range of groundfish management options, but such controversial options require substantial scientific research and evaluation before and during implementation to guard against unanticipated negative effects.

2nd Tier Priority - develop technological improvements in survey methods to make current surveys more cost-effective, and to evaluate potential new surveys for species found predominantly in untrawlable habitats.

VI. Management support--the status of stocks, manmade stress, and socioeconomic research areas provide a decision support system for sustainable fisheries. They provide technical guidance by describing and analyzing the current status and trend in fishery resources, their habitat, and fishery. The goal is to supply the best available scientific advice for management decisions, with associated uncertainty, on a timely basis.

2nd Tier Priority - evaluate long-term alternative management strategies

There is a strong interaction among these six areas of research. The first three research areas–Status of Stocks, Manmade Stress, and Socioeconomic–provide information for Management Support. Together, these areas of research are a decision support system with a primary orientation towards describing *what* is the current situation. Such an approach is a necessary component of an overall program, but the limited scope of such investigations may not be sufficient to assure long-term sustainability of valuable fisheries. There is a need for additional investigations that will provide better answers to resource management problems in the future. Investigation of Manmade Stress and Ecosystem&Climate will provide a fundamental understanding of *why* changes have occurred in the resource and its fishery. Research on Technological Innovations will provide new options on *how* we can have sustainable, valuable fisheries while preventing damage to the ecosystem. There will be a two-way interaction between these additional investigations and the core decision support system. The expanded work will rely upon the core program for extensive monitoring of the system and validation of new research results. It will return to the core program a set of new technologies and understanding that will improve the long-term performance of the core program.

I. STATUS OF STOCKS

The goal of research on status of stocks is to determine the health (status) of harvested stocks, and to forecast the potential fishery yield from a long-term harvest policy. Harvest recommendations involve balancing a sufficiently high harvest rate that will approach maximum sustainable yield against the probability of overfishing and causing a depletion of the resource or other harm to the ecosystem. The Sustainable Fisheries Act requires that a precautionary approach be taken to harvest management in the face of uncertainty on stock productivity. The SFA established formal requirements to identify overfished stocks and to establish rebuilding plans for these depleted stocks. Further, for species that exhibit extreme levels of depletion, the Endangered Species Act established a process for determining if there is a threat of extinction for any distinct population segment of the species.

Stock assessment models are at the core of the scientific basis for determining the status of fish stocks and estimating optimal harvest levels. These models of harvested fish stocks generally require three essential categories of data: abundance, fishery catch, and life history (*Figure 4*). These data come from fishery dependent and fishery independent sources. Models of the future will seek to incorporate more information on habitat, climate, and species interactions.

Abundance: The most reliable indicators of stock abundance are carefully standardized fishery independent resource surveys that track changes in abundance over many years. The best surveys have no bias (so their results are proportional to stock abundance), high precision (i.e., low sampling variability) in each year's survey result, and high frequency (i.e., annual) so that rapid changes in stock abundance can be tracked in a timely manner. In some cases, it is possible to conduct tagging studies, depletion experiments, or absolutely calibrated surveys such that the result is a direct estimate of population abundance, rather than just the trend in abundance. Surveys should provide age-specific results, and some survey methods may better track the adults, while other methods may better track young fish (recruitment).

Surveys can be conducted from fishery research vessels (FRV) and from chartered fishing and university vessels. In order to meet the many survey demands of a comprehensive program, NMFS plans to use both dedicated FRVs and chartered vessels. Chartered fishing vessels are able to effectively deploy fishing-type gear over a wide geographic areas, especially when several vessels operate at the same time. With a high level of attention to standardization of methods and measurement of gear performance, chartered fishing vessels can carry out many types of basic resource surveys. FRVs provide an even higher level of standardization and are designed specifically for multi-disciplinary fishery missions. They are acoustically quiet, nearly all-weather, can carry large scientific parties to collect maximum information from each sample, and can deploy several fishery, biological, and oceanographic samplers to accomplish multi-disciplinary objectives.

Fishery logbook data record catch and effort and, in some circumstances, can be analyzed to produce an indicator of changes in abundance. Logbook results can be precise because of the large number of tows made each year. However, it is difficult to assure accurate standardization so that results will be proportional to stock abundance changes, especially during periods of changing fishery regulations. Even if the logbook data cannot be standardized into an index of changes in abundance, these data still are extremely valuable for tracking changes in the locations of fishing activities and catch.

Catch - Total catch from commercial and recreational fisheries is determined from fishery dependent monitoring including mandatory reporting systems, shoreside samplers and interviewers, and at-sea observers. Increased use of electronic reporting systems will improve system accuracy, timeliness, and accessibility. The role of total catch data in stock assessment models is to indicate the magnitude of fishery removals during the time period in which the surveys have measured a change in abundance. Age-specific catch data allow age-structured population modeling, thus improving accuracy of calculated fishery impacts and estimates of recruitment to the stock.

Life history - These data on stock structure, growth, reproduction and natural mortality rates indicate the geographic limits of the population and the inherent productivity of each fish recruited to this population. Inclusion of life history data in stock assessment models helps assure biologically realistic results that properly separate fishing mortality from natural changes.

1st Tier Priority Research: Evaluate the Status of All Managed Groundfish Stocks

Although the Pacific Fishery Management Council's Groundfish Fishery Management Plan (FMP) has been in effect for 18 years, only 26 of the 82 species in the groundfish FMP have been assessed, and only 16 of these assessments have been backed by sufficient information to fully evaluate the stock status. Although several groundfish species are healthy, five of the quantitatively assessed species are overfished (bocaccio, Pacific ocean perch, canary rockfish, cowcod and lingcod), so there is a reasonable likelihood that some unassessed species are also overfished. The law requires that the status of all groundfish species in the FMP be evaluated to ascertain the condition of these stocks.

To accomplish this goal it is essential to recognize that the fishery data, life history information, and survey statistics needed to conduct detailed quantitative stock assessments are not available for all 82 groundfish species. Nor will those data be available in the foreseeable future. This shortage of information means that different approaches to evaluating stock condition will have to be developed and implemented on a stock by stock basis. In addition, holistic models, including assemblage, ecosystem, and meta-analyses, can be used to make inferences about the status of data-poor stocks using the information that is available from data-rich stocks. More stock assessment scientists will need to focus their attention on the groundfish fishery, and those scientists will need to devise new ways of quantitatively evaluating stock status and rebuilding scenarios in data-poor situations, while simultaneously expressing the uncertainty in their results.

1st Tier Priority Research: Reduce Uncertainties in Assessment of Managed Species

Reduced uncertainty in assessment of managed species means that we will be able to more confidently determine the status of the species with respect to overfishing criteria, and we will be able to recommend levels of harvest that can obtain a large fraction of the potential yield while confidently avoiding overfishing and harm to the ecosystem. While there is high uncertainty, larger precautionary adjustments in optimum yield are necessary to confidently avoid overfishing. Improvement in assessment certainty will come from improved quantity and accuracy of abundance, fishery catch, and life history information.

Some short-term, relatively low-cost improvements to stock assessments can be made. Improved

assessment models can better characterize the uncertainty, and the sources of this uncertainty, so that it is more clear where the greatest improvements can be made. Better information on the stock structure can lead to more accurate assessments through better alignment of the assessment data areas with actual stock boundaries. Incremental improvements in the collection of biological (age and growth) data from the fishery and surveys will improve assessment precision. Better standardization of existing fishery catch-per-effort data is another means to quickly improve our assessments.

Medium-term improvements in data are likely to lead to major improvements in assessment precision within 5 to10 years. These include large efforts such as annual resource assessment surveys, more comprehensive fishery logbook programs and at-sea monitoring of total catch, evaluation of fish association with particular habitats, and environmental monitoring. Not all of these survey and fishery studies should go into routine monitoring. Some of the survey effort needs to go into studies of factors that may influence survey standardization. New recruitment surveys can directly forecast changes in fish abundance. There also is a need to develop survey technologies to extend coverage to more species found predominantly in untrawlable habitats. Some of the fishery studies need to be in investigation of bycatch mortality. Many of these medium-term efforts are large scale and expensive, but have the greatest likelihood of significantly improving the precision of the assessments.

Longer-term improvements in assessments will require new kinds of information, particularly from the ecosystem and climate research area described below. In particular, studies of climate regime patterns will improve longer-term projection of average recruitment levels.

Plan for Priority Research

At the current funding levels we would conduct the following activities during the next three to five years, under the expectation of future program growth as described later. To some degree these status quo activities are modeled after much more data-rich programs and they can be successful only if significant program growth is achieved. If program growth appears unlikely, we must reevaluate and redirect these activities accordingly. The status quo effort includes:

a. Maintaining current schedule of trawl, acoustic, plankton and other surveys. Although a longer time series of these surveys will gradually improve the level of certainty in historical levels of exploitation, the current scope and frequency of surveys will not improve the basis for management decisions in the near future. Research listed later under technological innovations will seek to improve the accuracy of current surveys.

b. Improving ability to monitor the implementation of the rebuilding plans. We will work with states to review and adjust fishery sampling procedures to more accurately measure the low incidental catches of overfished species under rebuilding plans.

c. Analyzing and evaluating past fishery observer data to guide planning for a future observer program.

d. Conducting and reviewing approximately six to eight stock assessments per year. Competing demands for these assessments include: the required biennial evaluation of progress towards rebuilding of overfished stocks; updated assessments and optimum yield levels for healthy,

previously assessed stocks; and first-time assessments for more of the species with "unknown" status. In addition, some stock assessment expertise is needed to conduct status reviews of species petitioned for listing under the Endangered Species Act. At this rate, it will require many years to conduct an assessment for each groundfish species. To accelerate the assessment of all groundfish species and to set priorities for these assessments, we will: (a) assemble summaries of existing information for all species; (b) develop consistent, simple assessment approaches that can quickly be applied to many data-poor species; (c) and examine groupings (assemblages) of species that would provide an orderly and timely approach, for example a six-year plan that would rotate assessment effort among north-south, and nearshore-shelf-slope species groupings.

e. Filling some critical gaps in biological knowledge needed for accurate stock assessments. Priorities include developing ageing methodology for more species, particularly shortspine thornyheads, and determining the stock boundaries and structure for more species.

f. Improving assessment models to make the most complete use of available data and to communicate assessment results, with associated uncertainties, to managers and constituents. Efforts will include developing a simple approach for data-poor situations, a standardized approach to evaluating rebuilding time frames, and an approach to describing and communicating assessment uncertainty.

Expanded Fishery Monitoring - Improved fishery monitoring is necessary to provide needed information on total fishing mortality and rebuilding of overfished stocks. Major research needs are: observer programs, logbooks for more of the gear groups, improved recreational fishery monitoring, electronic logbooks, increased port sampling, and more comprehensive database integration. The costs for these elements are:

enhance commercial and recreational fishery sampling and electronic reporting system for fishery data	$1,500,000
observer program	$4,700,000

Expanded Resource Surveys - Greatly improved resource survey coverage and frequency is absolutely necessary if there is to be improved accuracy in monitoring the rebuilding of depleted stocks and if we are to ensure a sustainable harvest of healthy stocks. The mandatory biennial evaluation of rebuilding progress cannot be adequately conducted with only a triennial survey. A key element of this improved resource survey coverage is acquisition of a Fisheries Research Vessel to partner with chartered fishing and university vessels to conduct these surveys and other field investigations. The research that is needed includes:

a. Annual bottom trawl survey covering shelf and slope trawlable habitats. This is critical to monitor rebuilding of lingcod, bocaccio, canary rockfish, and Pacific ocean perch, as well as provide for accurate harvest recommendations for other species.

b. Expanded use of alternative survey methods, such as egg and larval surveys, particularly for species that are not accessible to the bottom trawl survey (nearshore rockfish and species south of Point Conception).

c. Annual hydroacoustic survey for whiting.

d. Recruitment surveys for key species, particularly whiting, sablefish, and major rockfish species.

Projected cost for increased surveys $3,500,000

Expanded Stock Assessments - We require expanded biological investigations, analysis staff and infrastructure to turn these increased fishery and survey data into timely stock assessments.

a. Life history and stock structure investigations to assure biologically valid assessments.

b. Improved frequency, timeliness, and comprehensiveness of the groundfish assessments, and improved communication of assessment methods and results.

Projected costs for increased assessments $2,000,000

II. SOCIOECONOMICS

Socioeconomic information and analysis is necessary to guide development of management actions that have fair and equitable impacts across all user groups and that obtain the greatest benefits from the use of marine resources. Besides satisfying statutory mandates, this socioeconomic information and analysis is necessary to guide development of management actions that have fair and equitable impacts across all fishery stakeholders and that obtain the greatest benefits from the use of marine resources. Allocation of available biological yield among user groups will continue to be a contentious issue, as will efforts to reduce the degree of overcapitalization in the harvesting and processing sectors. Additional longer-term work will be needed to develop an ability to predict how fishery participation or costs would change if there were major changes in the approach to fishery management or to changes in the long-term harvest policy

1st Tier Priority Research: Improve Socioeconomic Data Collection and Analysis

At present levels of funding and staffing, NMFS will make no significant progress on improvements in socioeconomic analyses for West Coast groundfish. Existing socioeconomic information and analytical capabilities of NMFS and the PFMC are barely able to respond to Magnuson-Stevens Act mandates and other regulatory impact analytical requirements.

A significantly expanded socioeconomic program is needed to guide development of options for achieving an economically viable fishery. Elements of this expanded program will include:

a. Improved data collection programs to cover the commercial, recreational and tribal fishery sectors, the processing and wholesaling sector, and fishing-dependent communities. Data needs include: processor and harvester cost, revenue, effort, and labor opportunity cost data; charter boat revenues, costs, labor expenditures and vessel characteristics data; fishing community jobs, household income, tax revenues, public services, infrastructure; fishing port geographic and physical descriptions; habitat-related economic data; and recreational expenditure and value (consumer surplus data).
b. Better policy evaluation through cost-benefit analysis, social impact assessment, bio-economic models, input/output impact analysis, nonmarket valuation, system behavior analysis including predicting fishery participation, and risk and trade-off analysis. These models will help understand the current year-round fishery and its trip limit regime, describe the socioeconomic impacts of alternative plans for rebuilding depleted fish stocks, and evaluate approaches and targets for capacity reduction.
c. Longer-term evaluation of market-based fishery management tools such as individual quotas, incentive/disincentive programs to manage bycatch, and other alternative tools of fishery management.

Costs of such an expanded socio-economic program are approximately $ 1,200,000

III. MANMADE STRESS

The goal of this line of investigation is to identify, understand and seek means to reduce manmade risks to fish stocks, their essential habitat, or other components of the ecosystem. Such investigations have a strong role in developing our ability to evaluate impacts on Essential Fish Habitat (EFH). These risks include all factors other than the direct effect of fishery catch, which is studied under the Status of Stocks topic. There will be significant interaction between study of these risk factors and the Ecosystem topic, which will include description of ecosystem functions and dependence of the ecosystem function on habitat. In addition to identifying risks, these studies will also seek to develop methods to reduce adverse impacts. Manmade stress factors include:

a. bycatch of non-harvested species - Many nontarget species, ranging from benthic invertebrates to seabirds, are taken in fishing gear. An assessment of the levels of this take and its effects needs to be undertaken to assure that harmful impacts are not occurring.
b. fishing gear impacts on benthic habitat - Fishing can produce changes in both the biotic and abiotic components of benthic marine habitats and communities.
c. other habitat alterations - Other human activities, such as mineral exploration, kelp harvesting, dredging, etc. can adversely affect the habitat and its ability to support historical levels of fish production. Global climate change is, in principle, a manmade habitat alteration, although its possible effects are presently indistinguishable from natural patterns in climate variability.
d. genetic and other nonlethal effects of fishing on fish populations - There are also population level consequences of fishing that may result from selective removal of large and fast growing or behaviorally dominant members of the population, e.g., reduction in genetic growth potential and overall genetic heterogeneity and delayed sexual maturation.
e. contaminant effects on fish health and other biota - Contaminants can directly affect the health of fish and other biota, and increase their susceptibility to disease and predation.
f. disease - The occurrence of die-offs in the ocean is not well documented, but the finding of diseased fish in heavily impacted estuaries suggest that fish disease needs further study, especially in habitats impacted by contaminants.
g. exotic species - Introduction of exotic species into our coastal waters upsets the natural biotic community and may have extreme impacts on some native species. Although an impact on groundfish species has not yet been identified, this is a growing threat, especially for species that utilize major estuaries.

2nd Tier Priority Research: Ecological Effects of Fishing

Of the many potential manmade threats to groundfish, the greatest current concern is from the ecological effects of fishing, including disturbance of the benthic habitat and bycatch of nongroundfish species. Both of these effects can impact the health and bio-diversity of the marine ecosystem and affect the ability of the system to support production of groundfish.

Fishing can produce changes in both the biotic and abiotic components of benthic marine habitats and communities. For example, fishing gear may alter the three dimensional habitat space available to benthic fishes and macro invertebrates by disturbing the substratum and/or removing or damaging macro invertebrates that constitute the habitat. The removal of both target and nontarget species undoubtedly alters benthic community structure and trophic dynamics. There are also population level consequences of fishing that may result from selective removal of large

and fast growing or behaviorally dominant members of the population, e.g., reduction in genetic growth potential and overall genetic heterogeneity and delayed sexual maturation. These potential impacts of fishing have presently unknown and/or unquantified effects on fishery ecosystems that must be understood to manage exploited stocks and conserve ecosystem function and productivity.

We need to determine which habitats are most susceptible to these impacts, and whether significant impacts are already occurring in some areas. Understanding ecological effects of fishing will lead to determination of means to reduce adverse impacts to acceptable levels. Expanding such research is currently a second tier priority behind the top tier stock assessment and socioeconomic issues. With present research efforts we will be able to:

a. Analyze existing data on fish distribution and benthic habitats, especially high resolution sea floor imaging data where available. These analyses would provide indications of changes in species distribution and abundance, community structure and benthic habitats over the last 10 to 20 years. These analyses would also identify habitat areas that are of particular importance to some of the species.
b. Begin preliminary investigation of the effects of fishing on the biotic and abiotic components of the habitat, using comparisons of lightly and heavily fished sites.

With an expanded program, we will:
a. Identify areas where fishing impacts may be the greatest. Include improved mapping of benthic habitats, improved mapping of fishing locations by all gear types, and improved mapping of fish distributions from fishery and survey data. These studies will leverage from improvements in survey coverage, development of a precise electronic logbook system, and emerging (e.g. electro-optics) technologies to rapidly image the seafloor and associated biota.
b. Conduct surveys in unfished reference habitats to compare to distribution and abundance, and community structure in fished habitat areas. Evaluate need for new research reserves in order to fully evaluate effects of fishing.
c. Conduct experimental fishing to determine the temporal and spatial dynamics of fishing gear impacts on the biotic and abiotic components of the habitat.

Expanded studies on ecological effects of fishing will cost: $1,000,000

IV. ECOSYSTEM AND CLIMATE INVESTIGATIONS

We need to be able to track natural and manmade changes in the ecosystem, predict their effect on fisheries, and adjust fishery management approaches to take these ecosystem factors into account. Ignoring these ecosystem factors may lead us to misjudge the cumulative effects of single-species management efforts. Some of these ecosystem changes are direct, such as the impact of habitat degradation on productivity of particular species. Other ecosystem changes are indirect and are caused by the predator-prey and competitive interactions between species, so will be much more difficult to predict. For example, we should know if the fishery-caused reduction in harvested fish abundance to near 1/3 of unfished levels (a single-species harvest policy) will cause major shifts in ecosystem function and its ability to support all groundfish fisheries in the future.

Ecosystem investigations need to take into account natural fluctuations in the climate that affect the ecosystem and groundfish productivity. In particular, decadal-scale shifts in the ocean climate appear to have dramatic effects on the productivity of fish stocks. Climate studies will: improve stock assessment accuracy by distinguishing historical fishing from natural causes in fish abundance; improve short-term forecasts of fishery potential yield by developing more timely estimates of fish recruitment; improve projections of timescales for fish stock rebuilding by taking into account decadal-scale cycles in productivity; and improve resource survey and fishery efficiency by predicting changes in fish distribution.

Ecosystem considerations also include improved knowledge of the various specific habitats used by the progressive egg-larval-juvenile-adult-spawner life stages. This knowledge of the spatial-temporal diversity of the ecosystem will assist in identifying the importance of particular habitats for groundfish production. This knowledge will be instrumental in evaluating whether marine reserves are a viable tool to assist in safeguarding fish stocks. Some of these habitat-specific ecosystem studies will have a high cross-over with studies under Manmade Stress - Ecological Effects of Fishing.

2nd Tier Priority Research: Identify and Forecast Decadal Changes in Stock Productivity

The most immediate need for ecosystem and climate research is to improve our ability to understand and predict ecological consequences of decadal scale shifts in the climate. These shifts occur rapidly as the components of the climate system realign themselves, moving from one state, or regime, to another in a period of months. The classic fisheries assessment and forecasting paradigm views recruitment as varying randomly about a single, long-term level. This paradigm is not consistent with the emerging view that there may be several, very different, mean recruitment levels, each one persisting for a decade or two followed by a rapid transition to another level. Improved forecasts of the time needed to rebuild overfished stocks require a better understanding of the effect of these regime shifts on fish productivity. NMFS' stewardship mission requires us to understand the relative role of past regime shifts on the decline of some groundfish, to forecast the effect of future regime shifts on rebuilding of these stocks, and to develop long-term harvest policies that take into account the expected effect of climate regime fluctuations.

At minimum, NMFS scientists must work with other NOAA scientists and our academic partners to develop diagnostic physical/biological ecosystem models to identify principal modes of ecosystem variation and, most importantly, to develop indicators of future regime shifts and their consequences. Development of such models requires analysis of historical time series data

(fishery-independent surveys, cooperative ecosystem surveys, catch, port sampling, atmospheric and sea-surface temperature, oceanographic buoys, shore station data, satellite information, output from complex ocean circulation models, etc.).

With our current capabilities, we will

a. Prepare a review of North Pacific climate patterns and California Current productivity related to groundfish.
b. Evaluate possibility of using recent climate information to refine estimates of rebuilding rates for overfished stocks.

An expanded program is needed to develop greater predictive ability by coupling increased environmental measurement with retrospective analyses and modeling. The accuracy and timeliness of predictions of regime changes, based on biophysical models, depends upon on the verification using a strong observational program and direct measurement of variables that can provide advanced warning of change. Thus in the optimal program, retrospective analysis and modeling would be coupled with an observational program consisting of both physical and biological measurements from moored instruments and bio-physical ocean surveys.
An expanded ecosystem and climate program will be able to:

a. Develop and calibrate relationships between physical climate information and historical patterns of fish recruitment.
b. Augment oceanographic monitoring programs to assure timely access to data relevant to forecasting fish recruitment and survival levels.
c. Conduct field studies to assure that the statistical relationships are based upon ecological information.

Expanded ocean monitoring and climate investigations will cost: $1,000,000

V. TECHNOLOGICAL INNOVATIONS

In addition to providing a better understanding of the system in which fisheries occur, we also need to take a lead role in developing technologies and knowledge to obtain the maximum benefits for fishing communities and the nation, and for cost-effective monitoring of this fishery and the affected stocks and ecosystem. Some of this new technology should go into improved methods for gathering and using data for Status of Stocks, Manmade Stress, and Ecosystem/Climate Investigations. Other aspects of this new technology will go into improving the value of the fishery. Some potential technologies to evaluate include:

a. Advanced technologies offer opportunities to conduct new resource surveys in currently unsurveyed habitats and to improve the standardization of existing survey technologies;
b. Timely and efficient fishery monitoring tools such as electronic logbooks and electronic fish tickets will improve the timeliness and accuracy of fishery data, thus reducing the possibility of over- or under-shooting harvest targets;
c. Improvements in fishing gear and methods to reduce bycatch and the mortality of bycatch;
d. The fishery may obtain greater benefits from a limited supply of fish if they can make more complete and value-added use of these fish. Relevant studies will include development and demonstration of technologies to more fully utilize the entire carcass of harvested fish, to utilize smaller fish caught along with larger targeted fish, to develop methods to produce safer and more valuable fish products;
e. New technologies for artificial propagation and culture of marine fish. Successful development of cost-effective and environmentally safe methods will enable expansion of aquaculture, enhancement of overfished and threatened wild stocks, and fuller understanding of the life history characteristics (e.g. feeding, growth, maturation, behavior) of target species.

2nd Tier Priority Research: Develop Cost-Effective Survey Technologies

A technological improvement that can make immediate improvements in west coast groundfish research and monitoring is the improved calibration of current survey methods and development of new methods. A variety of survey methods is needed for west coast groundfish. The most appropriate and cost-effective methodology for a particular groundfish species depends on many factors including life stage, habitat, susceptibility of the species to the gear, degree of control for environmental factors, etc. Some survey methods can provide only a measure of relative abundance; other methods are more amenable to direct calibration to absolute abundance. Some survey methods provide only a measure of the overall abundance of a stock, other methods also provide biological specimens to characterize the age and size composition of the population. Some methods provide only a measure of abundance for the total stock, other methods provide information on spatial distributions. Some methods cannot reach all habitats, while other methods can measure abundance across a full range of habitats. Some methods target a single species, others provide measurements for many species. Further, some methods require specialized vessels, while others can be adequately standardized for use on chartered vessels. Three categories of research are:

a. Understanding factors that affect the standardization of current survey methods. This includes everything that influences the degree to which the survey measurement is proportional to abundance of the targeted species. It includes study of fish behavior in different habitats and under different environmental conditions, and fish behavior in response to the sampling gear.
b. Development of new methods using advanced technologies. These include airborne and

underwater imaging systems, acoustics, tagging studies with coded wire tags, and highly calibrated egg and larval methods.

c. Standardization of unconventional data sources such as power plant impingement, predator stomach contents, and other sources that could be used as an index of changes in fish abundance.

With current levels of effort, there is little opportunity to significantly improve our surveys methods. However, we can:

a. Evaluate statistical ability of current level of survey effort and proposed unconventional data sources to detect trends in abundance;
b. Improve interpretation of current surveys through comparison to habitat data, fishery logbook data, and alternative means of observation such as submersibles and remote-operated vehicles (ROVs);
c. Assess alternatives for more efficient coverage of the groundfish habitat among the existing trawl surveys.

With an expanded research effort on survey methods:

a. Develop visual and laser systems to directly measure abundance and distribution of groundfish, especially in untrawlable habitat;
b. Evaluate egg and larval methods;
c. Conduct studies of fish behavior in response to survey sampling gear.

The cost of this survey improvement effort is: $900,000

VI. MANAGEMENT SUPPORT

The Status of Stocks, Manmade Stress, and Socioeconomic research areas provide a decision support system for sustainable fisheries. Their focus is on research and monitoring with the goal of providing the best available scientific advice for management decisions, with associated uncertainty, on a timely basis. A primary client for this scientific information is the Pacific Fishery Management Council and its advisory committees charged with development and evaluation of management options. Typical participants in this scientific support include economists and stock assessment scientists in the NMFS Science Centers and state agencies. Major functions of this decision support system include: conducting and reporting stock assessments; developing rebuilding plans; evaluating bio-socioeconomic impact of proposed fishery management measures; and assuring that best scientific advice has been used in these evaluations.

2nd Tier Priority Research: Evaluate Alternative Long-term Management Strategies

The current management paradigm used for West Coast groundfish is to establish a stock-specific Allowable Biological Catch (ABC) that is biologically-based and is derived from information on current stock size, the stock size at which Maximum Sustainable Yield (MSY) is obtained, and the exploitation rate that produces MSY. From that information an Optimum Yield (OY) is set by the PFMC to control total catch, and vessel limits are imposed and adjusted periodically with the goal of distributing the quota seasonally to achieve a year-round fishery. This particular system has become increasingly unwieldy, burdensome, and untenable over time due to a wide variety of factors, including: an inadequate base of existing information; rising and competing demands on data collections systems and stock assessment scientists; economic disruption to the fishery caused by continually reduced quotas/trip limits; escalated discards of marketable species; and heightened concern of widespread habitat degradation and adverse ecosystem effects.

Alternative strategies to manage and rebuild West Coast groundfish fisheries must be developed and evaluated if this situation is to improve. The PFMC is undertaking strategic planning to consider options to address the biological, economic, and sociological problems that plague the groundfish fishery. A number of different management approaches have generated interest from various groundfish constituents. These include, but are not limited to:

a. establishing a system of private harvest rights;
b. ending the open access policy, so all participants would be part of a limited license system;
c. reduced capitalization through permit/vessel buy-back programs;
d. seasonal closures that would reduce discard by ending the opportunity to fish year-round;
e. implementing no-take zones to protect a portion of stocks and habitat from fishery impacts;
f. stock enhancement programs to accelerate rebuilding; and,
g. social systems for co-management of the groundfish fishery.

Fishery science needs to take an anticipatory approach to development of new management options and scientific evaluation of any proposed options. In this way it assures that modifications to existing management procedures are, whenever possible, based on the best available science. Current socioeconomic capability that could contribute in this area will be saturated by providing critical technical support to the current management process. Under status quo, NMFS will continue to have to rotate its management support functions among existing staff, with little opportunity to engage in longer-range development. An expanded effort to develop and evaluate alternative approaches would look at a range of biological, technical, and

economic possibilities. We would:

a. Hire bio-economic modelers to provide a broad examination of such possibilities;
b. Build more comprehensive decision-support models for use by technical teams preparing routine analyses, such as trip limit changes, for fishery managers.

The cost of this bio-economic team is: $250,000

CONCLUSION

This research plan for West Coast groundfish is designed to provide a framework for prioritization of research and monitoring activities. Six research areas are identified: Status of Stocks, Socioeconomics, Manmade Stress, Ecosystem and Climate, Technological Innovations, and Management Support. Within each research area, we identify priority topics where there is an immediate need for expanded research and monitoring. Such an expansion is critical if the West Coast groundfish fishery is to attain a valuable, sustainable status. Accurate scientific information is necessary on an ongoing basis to guide achievement of optimum yield levels without exerting an excessive risk of overfishing or other harm to the marine ecosystem. This plan has been developed by the NMFS taking into account the results from several research planning efforts by the PFMC and constituent groups. We intend that the execution of this plan also be a collaborative effort among the several involved agencies and interested constituent groups.